

The Development of Infant Discrimination of the Tempo of Speech: An Extended Reliance on Temporal Synchrony

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Background

Communication skills including speech and affect perception are promoted by sensitivity to amodal properties (e.g. tempo, rhythm). According to the Intersensory Redundancy Hypothesis (IRH; Bahrick & Lickliter, 2012, 2014), detection of amodal properties is facilitated when they are redundantly specified across multiple sense modalities as compared with when they are detected through a single sense alone. Consistent with this prediction, Bahrick et al. (2012) reported that 2.5- and 5.5-month-old infants discriminated a change in the tempo of fluent speech during audiovisual synchronous but not unimodal visual stimulation. However, older infants (with additional perceptual expertise) typically detect changes in amodal properties when audiovisual synchrony is absent. For example, infants extend sensitivity to affect during speech from synchronous audiovisual (3-mos) to unimodal auditory (5-mos), followed by unimodal visual speech (7-mos; Flom & Bahrick, 2007). Similarly, from 3- to 5-months, infants extend tempo discrimination in nonsocial events (e.g., hammer tapping) from synchronous audiovisual to unimodal visual stimulation (Bahrick & Lickliter, 2004). In contrast, infants in Bahrick et al. (2012) did not extend their discrimination of tempo from synchronous audiovisual to unimodal visual speech between 2.5- and 5.5-months, demonstrating an extended reliance on audiovisual synchrony. The present studies examined when and under what conditions infants discriminate the tempo of fluent speech in the absence of audiovisual synchrony.

General Methods

Infants of 5.5 and 9-11 months participated in visual habituation studies. Infants were habituated to one woman reciting a nursery rhyme at one tempo (130, 145, 175, or 190 syllables per minute; spm) and were then shown two test events with the same woman speaking at a different tempo (either 45 spm faster or slower). Infants in all studies received the same actresses and tempo contrasts. Ability to successfully discriminate the change in tempo of speech was measured by visual recovery (mean looking time on test trials minus mean looking time on post-habituation trials) to the two test trials.

Experiment 1: 5.5 months- Unimodal Auditory Speech (N=16)

Experiment 1 assessed whether 5.5-month-olds would discriminate the tempo of speech during unimodal auditory stimulation. Although infants at 5.5 months were unable to discriminate the tempo of visual speech, we hypothesized that perhaps sensitivity to tempo would be greater for unimodal auditory than unimodal visual speech. Infants were habituated and tested to static images of a woman accompanied by her voice speaking a nursery rhyme. However, infants showed no evidence of visual recovery to a change in the tempo of unimodal auditory speech, $t(15)=1.03$, $p=0.32$ (Figure 2).

Experiment 2: 5.5 months- Asynchronous Audiovisual Speech (N=16)

Experiment 2 explored whether 5.5-month-olds would discriminate the tempo of speech when both visual and auditory speech depicted the same tempo, but were presented asynchronously (temporally misaligned). This equates the amount of audio-visual stimulation with that of the synchronous condition, while eliminating intersensory redundancy. Infants showed no evidence of visual recovery during audiovisual asynchronous speech, $t(15)=0.48$, $p=0.64$ (Figure 2), indicating the importance of audiovisual synchrony for tempo detection.

Figure 1. Static images depicting the habituation and test phases for one tempo condition with one of the four actresses, with a tempo of 145 syllables per minute (spm) for habituation phase and 190 spm for test phase

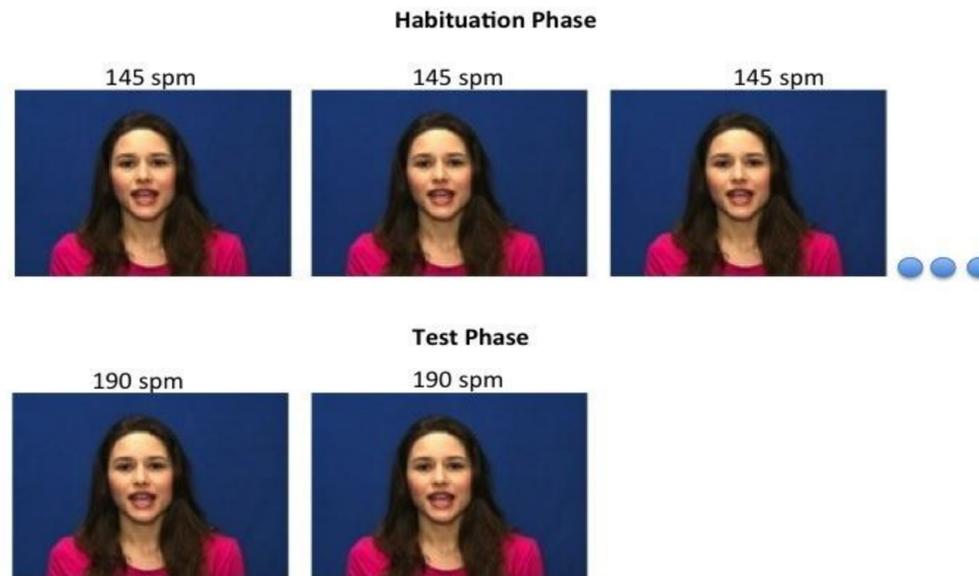
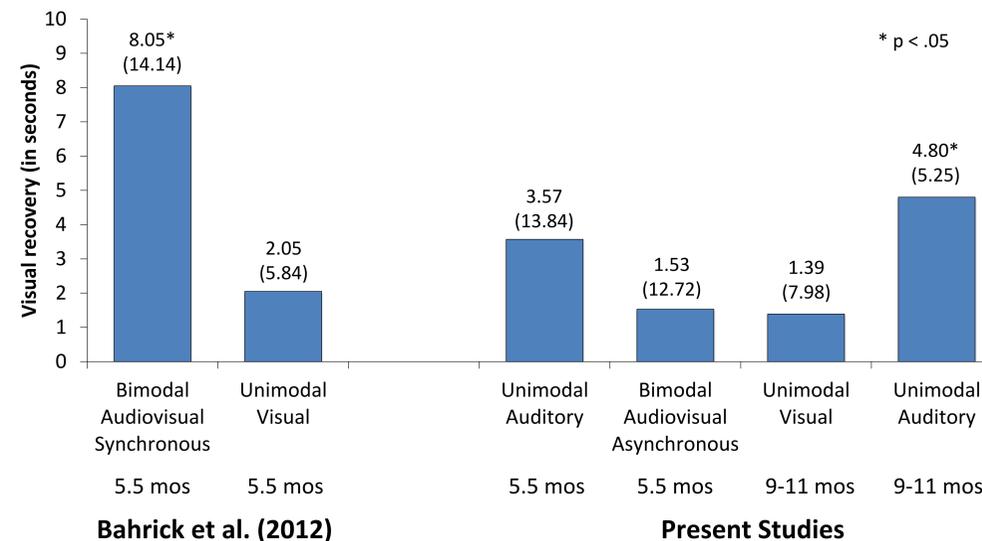


Figure 2. Visual recovery (increase in looking time, in seconds) to test events depicting a change in the tempo of speech for 5.5- and 9-11-month-olds as a function of condition (bimodal audiovisual synchronous, unimodal visual, unimodal auditory, and bimodal audiovisual asynchronous).



Experiment 3: 9-11 months- Unimodal Visual Speech (N=16)

Experiment 3 assessed whether older infants (9-11-months) would discriminate the tempo of speech during unimodal visual stimulation. Following habituation to a woman speaking silently, infants showed no visual recovery to test trials depicting a visual change in the tempo of speech, $t(15)=0.79$, $p=0.44$ (Figure 2).

Experiment 4: 9-11 months- Unimodal Auditory Speech (N=6)

We are currently assessing whether older infants (9-11-months) can detect a change in the tempo of speech in unimodal auditory stimulation. Preliminary results indicate that infants of this age can, in fact, detect auditory changes in the tempo of speech, $t(5)=3.25$, $p=0.023$.

Conclusions

Our prior findings demonstrated tempo discrimination by 5.5-month-olds in the context of intersensory redundancy from synchronous audiovisual speech. Infants performed similarly in the present studies, in both unimodal auditory or asynchronous audiovisual stimulation, conditions where intersensory redundancy is absent. Surprisingly, even older infants (9-11 months) failed to discriminate a change in tempo in unimodal visual speech. However, preliminary data did suggest that older infants show sensitivity to a change in tempo in unimodal auditory speech. Together, these findings demonstrate the powerful role of intersensory redundancy in infant perception of the tempo of speech. Infants show an extended reliance on audiovisual synchrony as compared with detection of tempo in nonsocial events, where unimodal visual sensitivity emerges by 5-months of age. Future studies will explore the age at which infants are sensitive to tempo changes in unimodal visual speech.

References

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